EN200

LAB #2 PRELAB

NUMERICAL INTEGRATION

Instructions:

1.   The first part of this lab consists of a prelab that covers the theory of numerical integration.

2.   The prelab is to be completed and submitted to your instructor at the beginning of the lab period.

3.   When completing the prelab, attempt to answer all questions without referring to your notes. Only refer to your notes when you are confused or fail to understand a concept. This will greatly improve your understanding of the concepts that this lab is designed to reinforce. Remember, you will have no notes during quizzes, tests, or exams.

4.   All work must be shown on your lab for proper credit. This means that you must show generalized equations, substitution of numbers, units, and final answers. Engineering is communication of ideas. Work that is neat and shows a logical progression is easier for anyone reviewing your work to understand.

Student Information
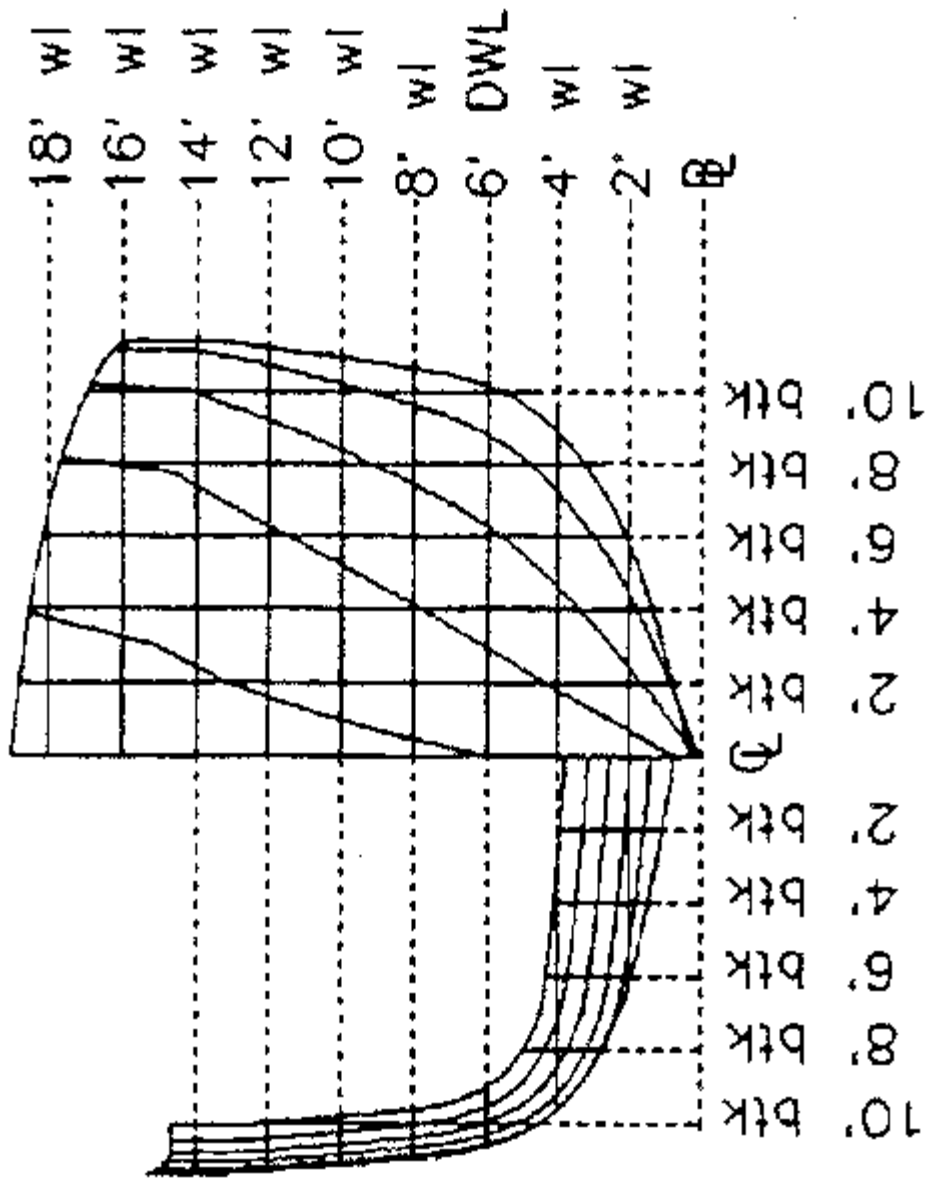
Name: _____

Section: _____

Date: _____

Figure 1: YP Body Plan

Aim

- Reinforce the student's understanding of a ship's hull form, specifically waterlines, waterplanes, and sections.

- Reinforce the student's use of Simpson's First Rule to calculate areas, volumes, and centroid of an area of a hull given the hull's table of offsets.

- Prepare students to use a spreadsheet program for performing repeated numerical calculations.

- Re-familiarize students with the use of spreadsheet programs to perform routine calculations and as a plotting tool.

Table of Offsets

Given below is the table of offsets for a YP. This table is to be used for the remainder of the prelab. This same table will be given in the spreadsheet used during the lab.

YP Table of Offsets

DWL = 6 ft   Lpp = 101.7 ft   Half-breadths in feet from the centerline

STATION NUMBERS – Station 0 is the FP, Station 10 is the AP

Draft (ft)	0	1	2	3	4	5	6	7	8	9	10
10	1.1	5.2	8.6	10.1	10.8	11.1	11.0	10.8	10.6	10.1	9.7
9	0.8	4.7	8.1	9.7	10.6	10.9	10.8	10.7	10.4	10.0	9.6
8	0.5	4.1	7.6	9.4	10.4	10.8	10.7	10.6	10.2	9.9	9.5
7	0.3	3.6	7.0	9.1	10.2	10.7	10.6	10.5	10.1	9.7	9.4
6	0.1	3.0	6.3	8.7	10.0	10.6	10.5	10.2	9.8	9.5	9.0
5	0.0	2.4	5.5	8.2	9.5	10.1	10.1	9.7	9.3	8.8	8.0
4	0.0	1.9	4.5	7.3	8.8	9.4	9.5	9.1	8.4	7.3	3.5
3	0.0	1.3	3.5	6.2	7.5	8.2	8.6	7.5	5.0	0.0	0.0
2	0.0	0.8	2.3	4.5	5.3	6.0	5.5	2.0	0.0	0.0	0.0
1	0.0	0.2	1.0	2.2	2.2	1.7	0.0	0.0	0.0	0.0	0.0
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Verifying the Table of Offsets

1.   Verify the offsets for stations 0, 1, 2, 3, and 4 at the 6-foot waterline (DWL) by measuring them on the body plan in Figure 1 and comparing them to the values in the table of offsets. Show that you know how to find these points by circling them on the body plan in Figure 1. Insert the measured offsets and table values in the table below.

Station	0	1	2	3	4
Y Offset from Table of Offsets (ft)					
Y Offset from Body Plan (ft)					

Hull Definitions

2.   On the diagram in Figure 2 below, indicate the following items:

- Waterline
- Waterplane
- Section area
- Forward perpendicular
- Aft perpendicular

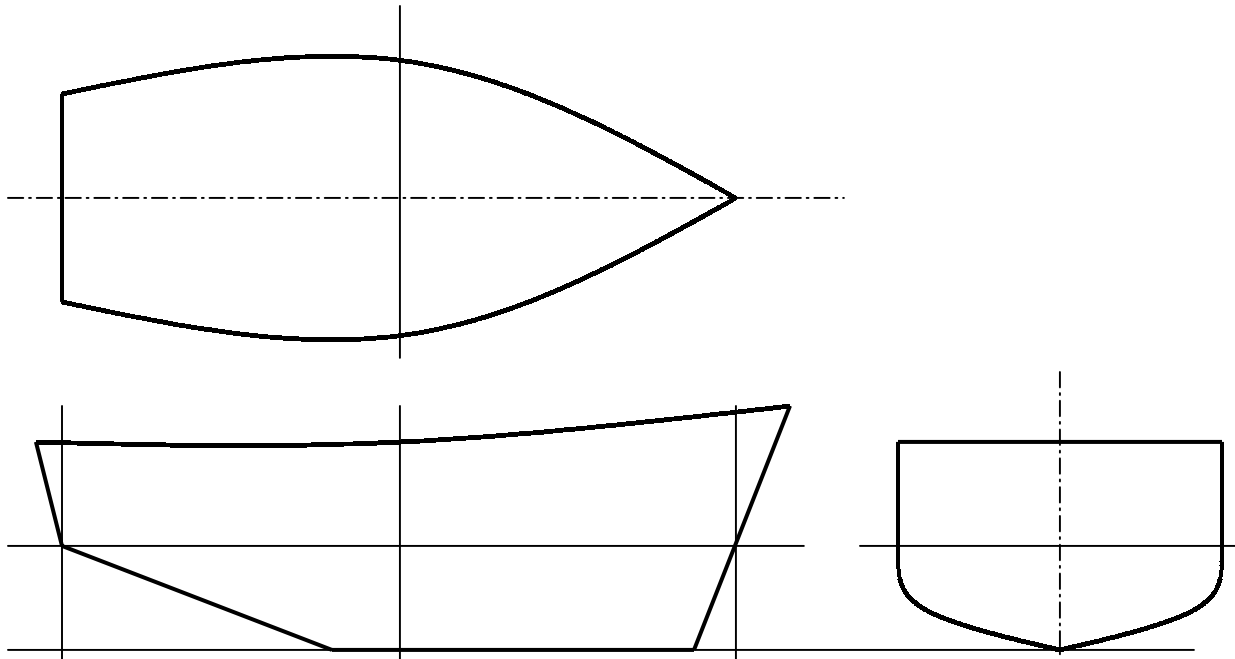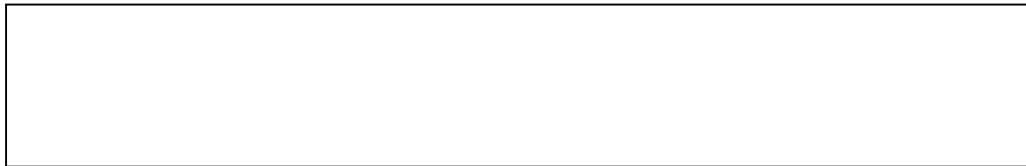- Centerline
- Baseline
- Midships
- Center of flotation

Figure 2: Diagram for hull form definitions

Sectional Area

3.   Using the table of offsets and Simpson's first rule, follow the steps below to find the sectional area of station number 5 up to the 6-foot waterline.

       a.   In the space below, sketch the section you are integrating and the differential element. Ensure you properly label the axes and the dimensions of the differential element.

       b.   In the box below give the generalized calculus equation for the sectional area integration.

       c.   Show how the equation is written using Simpson's first rule.

       d.   Substitute the relevant numbers and calculate the sectional area of station 5. Box your final answer.

Submerged Volume

4.   Using the following steps show how the submerged volume of a ship is calculated using Simpson's first rule.

      a.   In the space below sketch the volume you are integrating and the differential element. Ensure you label the axes and the dimensions of the differential element.

      b.   Give the generalized calculus equation for the submerged volume integration.

      c.   Show how the calculus equation is written using Simpson's first rule.

Waterplane Area

5.   Using the table of offsets and Simpson's first rule, follow the steps below to find the waterplane area at the 6-foot waterline.

      a.   In the space below sketch the waterplane you are integrating and its differential element. Ensure you properly label the axes and the dimensions of the differential element.

b.   In the box below give the generalized calculus equation for calculating the waterplane area at the 6-foot waterline.

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c.   Show how the calculus equation is written using Simpson's first rule.

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d.   Substitute the relevant numbers from the table of offsets and calculate the area of the 6-foot waterplane.

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Longitudinal Center of Flotation (LCF)

6.　　Using the table of offsets and Simpson's first rule calculate the position of the LCF at the 6-foot waterline referenced to the YP's forward perpendicular.

　　　a.　　In the space below sketch the area you are analyzing and its differential element. Ensure you properly label the axes and the dimensions of the differential element.

　　　b.　　In the box below write the generalized calculus equation for calculating the LCF.

　　　c.　　Write the general equation for the longitudinal center of flotation of the 6-foot waterplane using Simpson's first rule.

　　　d.　　Substituting the relevant values from the table of offsets, calculate the LCF of the 6-foot waterplane.

7.   The calculations you have just completed are just a portion of the numerous calculations required to obtain the hydrostatic properties of a ship. The previous calculations only obtained some of the hydrostatic parameters for the 6-foot waterline of the YP. The same values must now be computed at all other waterlines, starting with the keel. Obviously, you could continue doing the necessary hydrostatic calculations by hand, however, the advent of the computer and spreadsheet programs makes these repetitive calculations much easier.

8.   During the lab you will be using the Excel spreadsheet program. Prior to the lab, familiarize yourself with this program. Specifically, familiarize yourself with the formatting of equations and the development of graphs.

      Look up and write the programming syntax for the following function (look under the help function to find this):

              SUMPRODUCT: _____

9.   Write the programming syntax to calculate the following using Simpson's first rule:

      Sectional Area: _____

      Submerged Volume: _____

      Waterplane Area: _____

      LCF: _____

10. **Go to the Naval Architecture and Ocean Engineering home page, find the EN200 web page and download to disk the Excel version of Lab #2.**

ENSURE YOU BRING THIS DISK TO LAB!

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EN200

LAB #2

NUMERICAL INTEGRATION

1. This lab is conducted in one of the computer labs on the first deck of Rickover Hall. Your instructor will tell you which one.

2. You will need to bring this lab and a computer disk with "Lab #2" downloaded from the Naval Architecture and Ocean Engineering home page.

3. The lab is to be performed individually and submitted work must be your own. You can ask questions and get help but you must then complete the work on your own. **You are not to copy another person's disk or work.**

4. This lab is designed to be completed during the lab period. If you do not complete the lab in the allotted time, your instructor may give you additional time to complete the lab.

5. For full credit, all work must be shown. This means that you must show generalized equations, substitution of numbers, units, and final answers. Engineering is communication. If your work cannot be understood at first sight, then you are not writing the way you should be. You should take pride in the appearance of your work. Use a straight-edge and write neatly. Work that is neat and shows logical progression is easier to grade.

Student Information

Name: _____

Section: _____

Date: _____

Aim

- Reinforce the students' use of Simpson's first rule to calculate areas, volumes, and centroids of a hull given its table of offsets.

- Introduce students to the power and speed at which numerical integration can be performed using a spreadsheet.

- Introduce students to the speed and flexibility offered by a spreadsheet when plotting graphs representing numerical information.

Initial Tasking

1. Log on to your computer terminal and access the Naval Architecture and Ocean Engineering home page. Go to the EN200 site and download the Excel version of Lab #2. If you have not already done so save this file to your disk.

Sectional Area

2. Go to the **"Sectional Area and Submerged Volume"** tab on the spreadsheet.

3. Program the sectional area calculation into the spreadsheet and calculate the sectional area for each of the 11 stations up to the 6-foot waterline by following the steps below.

    a. Input the Simpson multipliers and waterline spacing (dz) into the appropriate spreadsheet cells.

    b. Use the function SUMPRODUCT to calculate the sectional areas. If you have difficulty doing this, use the "HELP" capability of the spreadsheet program to assist you. If you are still confused, ask one of your neighbors or instructor for assistance.

    c. Check your spreadsheet results by comparing the sectional area of station 5 with that calculated in the prelab.

Area of Station 5 up to the 6-ft waterline (spreadsheet calculation) (ft^2)	
Area of Station 5 up to the 6-ft waterline (hand calculation) (ft^2)	

    d. Comment on any differences between the two values.

    _____

    _____

    _____

4.   Repeating the procedure in Step 3, reprogram the spreadsheet to calculate the sectional areas for each of the 11 stations up to the 2 ft, 4ft, 8 ft, and 10 ft waterlines. Use of the spreadsheet's "copy" and "paste" functions may prove useful here.

5.   Using the spreadsheet's graphing capabilities, plot the sectional area curves at each draft on the same axes. As a reminder, the sectional area curve shows sectional (station) areas on the y-axis and length on the x-axis.
   - Use the "X-Y Scatter" graph as the graph type
   - Ensure each draft is its own series or curve on the graph
   - Ensure the graph is correctly titled, each curve is properly labeled, and that the axes are labeled with the appropriate name, symbol, and units.

   If you have difficulty, use the program's "HELP" capability. If you are still confused, ask one of your neighbors or instructor for assistance.

   Print your graph on a separate sheet of paper.

6.   What does the area under the curve of sectional areas represent?

   _____

   What is the naval architecture symbol for the area under the curve of sectional areas? ___

Submerged Volume

7. a.   Program the submerged volume calculation into the spreadsheet and calculate the submerged volumes of the YP at drafts of 2 ft, 4 ft, 6 ft, 8 ft, and 10 ft in the appropriate cells of the spreadsheet.

   b.   In the appropriate cells on the spreadsheet, calculate the YP's displacement in salt water at each draft.

8.   When you are satisfied that your calculations are correct, print out the spreadsheet page.

Waterplane Area

9.   Click on the **"Waterplane Area"** tab. A new table of offsets should be revealed.

10.   Program the waterplane area calculation into the spreadsheet and calculate the area of the 2-foot through 10-foot waterplanes by following the general steps below.

   a.   Input the Simpson multipliers and section spacing (dx) into the appropriate spreadsheet cells.

   b.   Use the function SUMPRODUCT to calculate the waterplane areas. If you have difficulty with this, use the program's "HELP" capability to assist you. If you are still confused, ask one of your neighbors for assistance. Place the waterplane areas in the appropriate cells.

   c.   Check your spreadsheet calculations by comparing the waterplane area of the 6-ft waterline with that calculated in the prelab.

Waterplane area of 6-ft waterline (spreadsheet calculation) (ft^2)	
Waterplane area of 6-ft waterline (hand calculation) (ft^2)	

   d.   Comment on any differences between the two values of waterplane area.

   _____

   _____

   _____

Longitudinal Center of Flotation (LCF)

11.   Program the LCF calculation into the spreadsheet and determine the position of LCF, as referenced to the forward perpendicular, for the 2, 4, 6, 8, and 10 foot waterlines in the appropriate cells of the spreadsheet.

   Check your spreadsheet calculations by comparing your result for the 6-foot waterline with that calculated in the prelab.

LCF of the 6-foot waterline (spreadsheet calculation) (ft aft of FP)	
LCF of the 6-foot waterline (hand calculation) (ft aft of FP)	

12.   Comment on any difference between the two values.

   _____

   _____

13.   Print out the spreadsheet page. You will be graded on proper labeling, formatting, and professional appearance of your work.

Finishing the Lab

14.   Save your spreadsheet file onto your 3½ inch disk. If you wish to work on this lab back in Bancroft Hall, ensure you save it in a format that your computer can read.

15.   Submit the lab in accordance with your instructor's instructions.